2 PHYSICAL AND HYDROLOGIC COMPONENTS

2.1 RAINFALL

In all SFWMM runs, rainfall is assumed to have the same temporal and spatial distribution as that which occurred historically. Since rainfall is the main driving force in the hydrology of South Florida, it serves as a good control variable for evaluating alternative ways of managing the system as a whole. For Lake Okeechobee, a lumped hydrologic system, a single time series of rainfall depths is input to the model. For the gridded portion of the model, a distributed hydrologic system, a daily time series of rainfall depths for each grid cell is used.

Lake Okeechobee

Rainfall accounts for about 40% of the total inflow to the lake and the remainder comes from structure discharge. Although spatial variability in stages can be large for the 728- sq.-mile Lake Okeechobee, a horizontal water surface profile is assumed within the 140-mile levee system (Herbert Hoover Dike) which outline the outer boundary of the lake. Lake water depths are calculated by subtracting lake bathymetry, defined at 2-mile square grid cells within the LOK water budget area (Figs. 1.3.5 and 2.1.1), from the simulated lake water levels which are expressed in ft NGVD. Lake Okeechobee daily cumulative rainfall values are arithmetic averages of daily cumulative estimates for selected grid cells within the same budget area (shaded LOK grid cells in Fig. 2.1.1). These estimates were obtained using the same method used for the grid-based portion of the model.

Grid-Based Portion of the Model

The basic input to the majority of the model domain is daily time series of rainfall depths for all grid cells. An estimation procedure is performed to assign a representative rainfall depth for each day and grid cell because rainfall gaging stations do not normally coincide with the centroid of the grid cells and most grid cells do not contain rainfall gaging stations. Two general methods are employed: 1) for a grid cell that do not contain any rainfall station, the value measured at the station closest to the centroid of the grid was used; 2) for a grid cell that contains at least one rainfall station, a weighted average of the data measured from all stations within the grid cell was used. On certain days when no data was available from a particular station (or if the data was erroneous), the data from the next closest station was used.

Six hundred sixty-five rainfall stations with varying periods of record were used to generate the set of rainfall data. Figure 2.1.1 shows the distribution of these rainfall stations which are concentrated more densely on the eastern seaboard (LEC service areas) of the state than in the interior areas (Water Conservation Areas). Initially, the data was screened for erroneous values which might have been inadvertently included in the database. These values were flagged and not included in the actual assignment of rainfall depths for each cell. In cases where rainfall data, which are usually recorded as one-day cumulative amounts, had been accumulated over time, e.g., three days over the weekend, the values were distributed over the accumulation period based

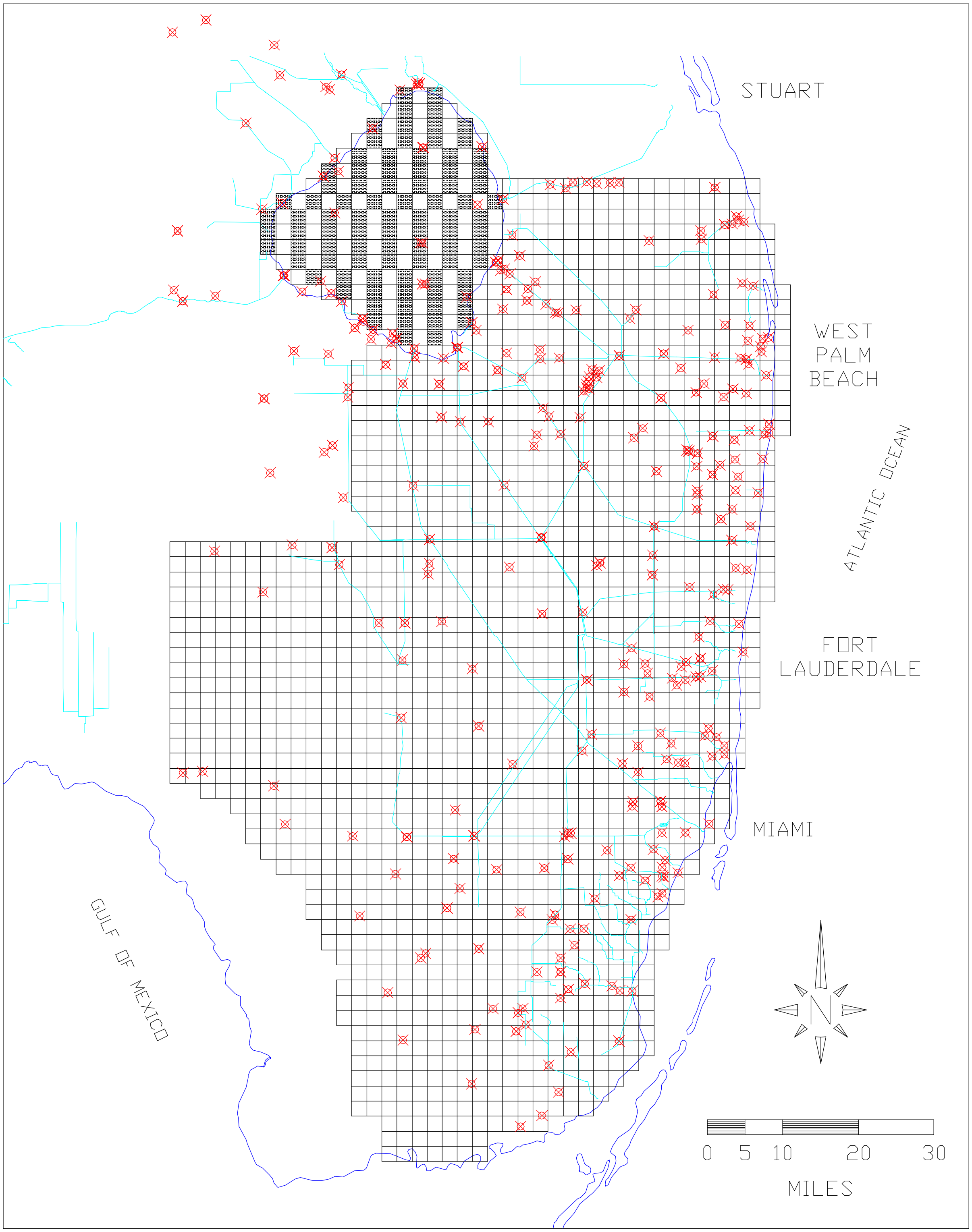

Figure 2.1.1 Location of Rainfall Stations Used to Create Rainfall Input Data for the Computational Grid Cells in the South Florida Water Management Model

on the distribution of rainfall at the closest available station over the same time period. This procedure can be represented by the following formula.

$$P_{s,\ t} = \frac{P_{b,\ t}}{\sum_{t\ =\ 1}^{T} P_{b,\ t}} \times P_{s,\ T} \qquad (2.1.1)$$

where:

$P_{s, t}$ = estimated precipitation or rainfall depth at station s on day t where a cumulative reading of T days was made;
T = number of days of accumulation;
$P_{b, t}$ = measured rainfall depth at nearest station b which will be the basis for the estimated rainfall depth at station s on day t; and
$P_{s, T}$ = cumulative rainfall depth at station s for the entire period of T days.

Data patched in this way and had not been flagged as erroneous was considered valid data.

For grid cells without a rain gage, the estimated rainfall depth becomes a function of the distance between the center of the grid cell and the nearby rainfall stations. The distance between the center of each grid cell and an external rainfall station is computed as:

$$d_{c,\ s} = \sqrt{(X_s - X_c)^2 + (Y_s - Y_c)^2} \qquad (2.1.2)$$

where:

$d_{c, s}$ = distance between center of grid cell c and external rainfall station s;
X_c = X-coordinate of the center of grid cell c;
Y_c = Y-coordinate of the center of grid cell c;
X_s = X-coordinate of rainfall station s; and
Y_s = Y-coordinate of rainfall station s.

Therefore, the computation of daily areal rainfall based on rainfall station/s outside a specific grid cell can be expressed in terms of the following equation:

$$P_c = P_s \qquad (2.1.3)$$

where:

P_c = estimated areal rainfall depth for grid cell c; and
P_s = measured rainfall depth for station s whose location is the closest (compared to all rainfall stations) to the center of cell c.

If at least one rainfall station is located within a grid cell, the estimated daily rainfall depth for the grid cell on the same day becomes the arithmetic average of all validated rainfall depths measured at the corresponding internal rainfall stations. The formula used is

$$P_{c,\ t} = \frac{\sum_{n=1}^{N} P_{n,\ t}}{N} \tag{2.1.4}$$

where:

$P_{c,\,t}$ = estimated total rainfall depth at cell c on day t;
$P_{n,\,t}$ = valid rainfall depth on day t at station n within grid cell c; and
N = number of rainfall stations in grid cell c with valid data.

The above approach may not yield the best estimate of rainfall but it affords several advantages over different interpolation/estimation methods. These include:

1. With a fairly large set of raw data, as in the case of the SFWMM, no estimation of missing rainfall data is required. Although rainfall is a continuous variable, a value of zero is not uncommon.

2. Most interpolation methods tend to assign non-zero values for days when no recording is made. The method employed in both models uses the next best estimate of the rainfall by using the closest available rainfall station.

3. The current estimation method is flexible enough to accept updated information and additional rainfall stations as they become available.

Daily rainfall data for the period of 1965 to 1995 was generated for the regional models on a grid cell basis as an improvement over the previous method of estimating rainfall data for predefined rainfall basins. The current method was chosen primarily because of its simplicity. Data were screened for erroneous values and cumulative data disaggregated. Analysis of model output may result in the detection of more questionable data values. The adopted method can be modified as more stations become available and more accurate methods for estimating daily rainfall are developed.